PATENT SPECIFICATION

DRAWINGS ATTACHED

911,170

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International Classification:—H02k.

COMPLETE SPECIFICATION

Improvements relating to the Cooling of Dynamo-Electric Machines

We, SOCIETE GENERALE DE CONSTRUCTIONS ELECTRIQUES ET MECANIQUES (ALSTHOM) a Corporation of the Republic of France, having its registered office at 38, Avenue Kleber, Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to dynamo-electric machines and particularly to cooling arrangements for the rotors of such machines.

The maximum power of a dynamo-electric machine is dependent on the efficiency of the cooling system employed, and is not usually limited by the stator cooling arrangement which can be liquid-cooled and would allow much higher power to be attained, but by the rotor cooling arrangement which is commonly gas-cooled, owing to the difficulty of conveying a liquid coolant to and from the rotating parts. Thus a considerable increase in the maximum power could be obtained by providing a liquid-cooled arrangement for the rotor and it is an object of this invention to provide such an arrangement.

According to the invention a cooling arrangement for the rotor of a dynamo-electric machine comprises a first centrifugally operated pump rotationally fast with the rotor and arranged to impel a liquid coolant into ducts extending through said rotor, a second centrifugally operated pump rotationally fast with said rotor and arranged to extract liquid coolant from said ducts and eject it, means for collecting the ejected liquid coolant and means for injecting a supply of coolant into said first pump.

In order that the invention may be more clearly understood reference will now be made to the accompanying drawings in which:—

Fig. 1 illustrates diagrammatically one example of a liquid-cooled winding assembly of a rotor;

Fig. 2 illustrates an alternative form for the winding assembly shown in Fig. 1;

Fig. 3 shows schematically and in elevation with a partial section along the line A—A in Fig. 2, a rotor embodying the invention;

Fig. 4 shows on an enlarged scale a connecting pipe shown in Fig. 3;

Fig. 5 shows a fragmentary view of an alternative form for the connecting pipe shown in Fig. 4;

Fig. 6 shows in elevation and partial section an example of an alternative form of connection between the winding assemblies and the container; and

Fig. 7 shows on an enlarged scale a section along the line B—B in Fig. 6.

Referring in the first instance to Figs. 1 and 2, a winding assembly 1 having one or more tubular ducts 23 therein, through which a liquid coolant can flow, is connected to two tubular members 2 and 3 which serve respectively as an inlet and an outlet for the liquid coolant. The conductors constituting the winding can themselves be hollow and form the ducts 23. The members 2 and 3 can be arranged adjacent each other as shown in Fig. 1, in which case a duct 23 forms a single path from one to the other, or alternatively the members 2 and 3 can be arranged at opposite sides of the winding assembly 1 in which case a duct 23 forms two parallel paths from one to the other.

Referring now to Fig. 3, a rotor 4 rotationally fast with a shaft 8 has mounted thereon a plurality of winding assemblies 1 similar to that shown in Fig. 2. The tubular member 2 of each winding assembly 1 is connected to a centrifugally operated pump 5, which is constituted by an annular container 7 of channel shaped cross-section rotationally fast with the shaft 8 and arranged with its open side facing towards the rotational axis of the shaft 8. A stationary distributor 10 which supplies the

[Price 4s. 6d.]

liquid coolant to the pumps 5, comprises a plurality of nozzles projecting into the open side of the container 7 and orientated in such a way that jets of liquid coolant ejected from the nozzles emerge tangentially to the movement of rotation of the container 7. The distributor 10 is connected by a pipe system 9 to a refrigerant 17 which is in turn connected to a reservoir 15 for the liquid coolant. The tubular member 3 of each winding assembly 1 is connected to a centrifugally operated pump 6 constituted by an annular member 11 of T shaped cross-section arranged rotationally fast with the shaft 8 so that the cross arm of the T is away from and parallel to the shaft 8. Each tubular member 3 communicates with an aperture 12 which extends through the stem of the T and emerges through the cross-arm to form an outlet through which the liquid coolant can be ejected. A stationary annular tank 13 of substantially channel-shaped cross-section, and having inturned flanges at its open side, encloses the cross-arm of the member 11 so that the apertures 12 open on to the closed side of the tank 13. A pipe 14 connects the tank 13 to the reservoir 15. A motor pump 16 is arranged to impel the liquid coolant in the reservoir 15 through the refrigerant 17 into the pipe system 9, the pressure furnished by the pump 16 being such that the speed of the jets of liquid emerging from the nozzles of the distributor 10 is substantially equal to the peripheral speed of the liquid coolant in rotation in the container.

When the rotor 4 is rotated during operation, the liquid coolant in the container 7 is compressed under the action of its own centrifugal force and impelled into the tubular members 2, so that it flows through the ducts 23 and the tubular member 3 into the pump 6. The liquid coolant in the apertures 12 is also compressed under the action of its own centrifugal force and is ejected into the tank 13 from whence it flows into the reservoir 15 to be impelled by the pump 16 to supply the pump 5, so that it begins the circuit again. It will be apparent that the movement of the liquid coolant between the pumps 5 and 6 is only possible if the product m d R w^2 is greater than the load losses of the circuit, where d is the difference between the external radius of the annular member 11 and the internal radius of the ring of liquid coolant in the tank 7, R is half the sum of the two radii, m the specific weight of the liquid coolant and w its angular velocity. When winding assemblies 1 similar to that shown in Fig. 1 are employed, the pumps 5 and 6 are rotationally fast with the same axial end of the rotor 1.

In order to avoid earthing the windings of the rotor 4 the tubular members 2 and 3 can each be constituted by metal tubes connected together by an insulating element 18, which can be a section of insulating tube forming an external sleeve on two metal tubes as shown in Fig. 4 or can be a similar section of insulating tube arranged to lap the outside of one tube and slip into the inside of the other as shown in Fig. 5.

Instead of providing one tubular member 2 and one tubular member 3 for each winding assembly 1 as shown in Fig. 3, the construction can be simplified by connecting a number of winding assemblies 1 to each of the tubular members 2 and 3. Referring now to Figs. 6 and 7 which illustrate one form of connection between the container 7 and the winding assemblies of the rotor 4 presenting this advantage, the container 7 constituting the centrifugal pump 5 is connected to a tubular channel 19 common to a plurality of winding assemblies 22. The channel 19, which extends axially in the body of the rotor 4, and can be constituted by holes in the body of the rotor 4 or by tubes, is extended radially by hollow insulating members 20 closed at their ends, and connected by pipes 21 to the winding assemblies 22, these pipes 21 being arranged alternately on one side or the other of the hollow insulating members 20.

Although in the arrangements previously described the ducts 23 are formed in the winding assembies 1, similar arrangements can be provided for cooling the body of the rotor by providing suitable ducts for the liquid coolant therein.

WHAT WE CLAIM IS:—

1. A cooling arrangement for the rotor of a dynamo-electric machine comprising a first centrifugally operated pump rotationally fast with the rotor and arranged to impel a liquid coolant into ducts extending through said rotor a second centrifugally operated pump rotationally fast with said rotor and arranged to extract liquid coolant from said ducts and to eject it, means for collecting the ejected liquid coolant and means for injecting a supply of liquid coolant into said first pump.

2. A cooling arrangement according to Claim 1 in which the centrifugally operated pumps are disposed at axially opposite ends of said rotor.

3. A cooling arrangement according to Claim 1 or Claim 2 in which said first centrifugally operated pump comprises an annular container having an opening extending around its inner periphery and arranged co-axially with the rotational axis of the rotor.

4. A cooling arrangement according to Claim 3 in which said container is channel-shaped in cross-section.

5. A cooling arrangement according to Claim 3 or Claim 4 in which the means for injecting the liquid coolant comprises one or more nozzles directed into the opening in said container.

6. A cooling arrangement according to any one of the preceding claims in which the

second centrifugally operated pump comprises one or more outlets communicating with said ducts and radially disposed with respect to the axis of rotation of the rotor.

7. A cooling arrangement according to Claim 6 in which said outlets are formed by apertures extending radially to the periphery of an annular member.

8. A cooling arrangement according to Claim 6 or Claim 7 in which the means for collecting the ejected liquid coolant comprises an annular tank having an open side into which said outlets project.

9. A cooling arrangement according to Claim 8 in which said tank is substantially channel-shaped in cross-section.

10. A cooling arrangement according to any preceding claim in which the ducts are formed in the conductors constituting the windings of the rotor.

11. A cooling arrangement according to any preceding claim in which two or more ducts are connected to the container by a common pipe.

12. A cooling arrangement according to any preceding claim in which two or more ducts share a common outlet.

13. A cooling arrangement for the rotor of a dynamo-electric machine substantially as hereinbefore described with reference to Figs. 1 and 3 of the accompanying drawings.

14. A cooling arrangement for the rotor of a dynamo-electric machine substantially as hereinbefore described with reference to Figs. 2 and 3 of the accompanying drawings.

15. A cooling arrangement for the rotor of a dynamo-electric machine substantially as hereinbefore described with reference to Figs. 2, 3, 6 and 7 of the accompanying drawings.

16. A cooling arrangement for the rotor of a dynamo-electric machine substantially as hereinbefore described with reference to Figs. 1, 3, 6 and 7 of the accompanying drawings.

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Fig. 1

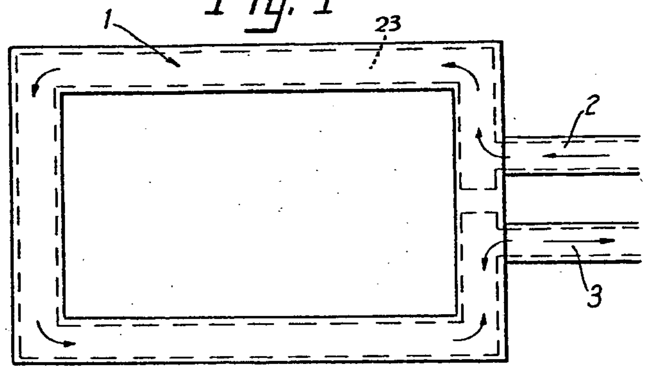


Fig. 2

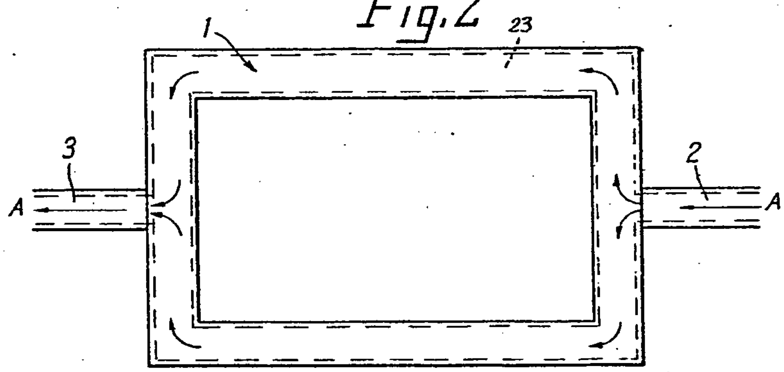


Fig. 4

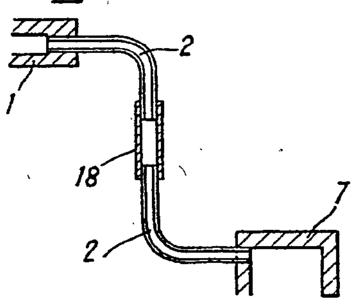
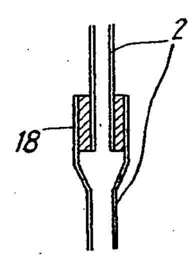
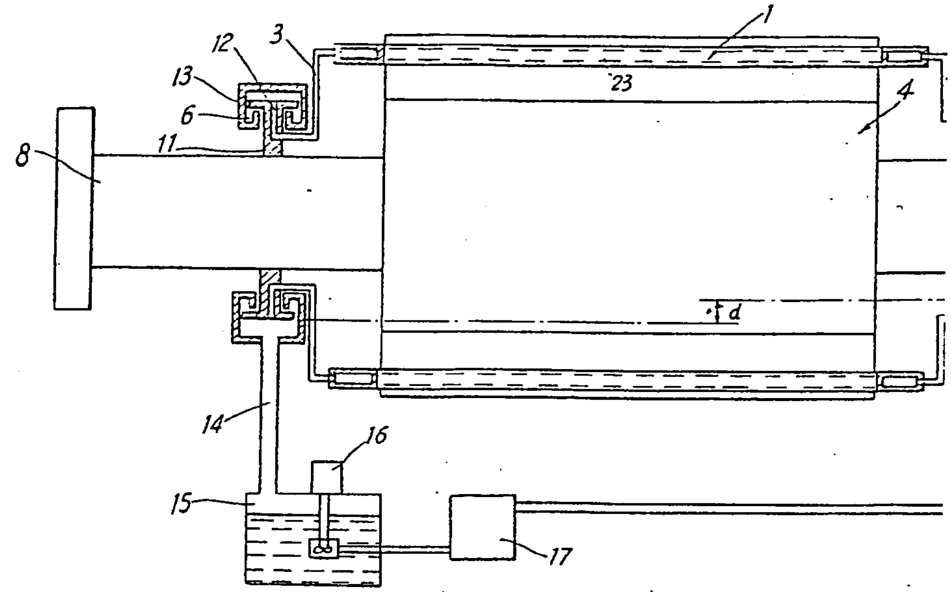


Fig. 5

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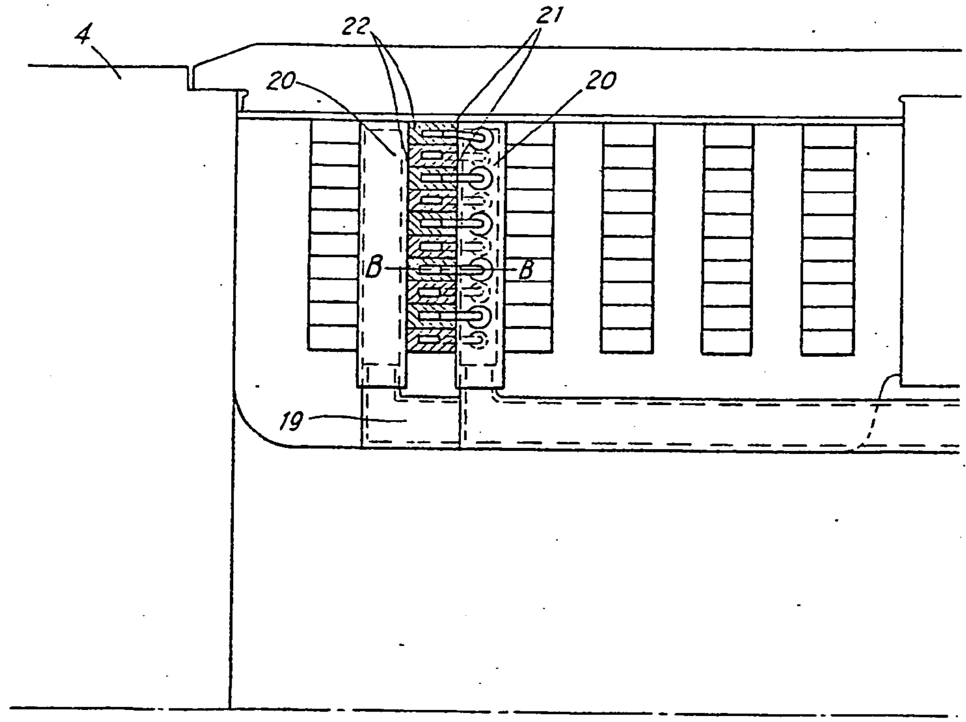
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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

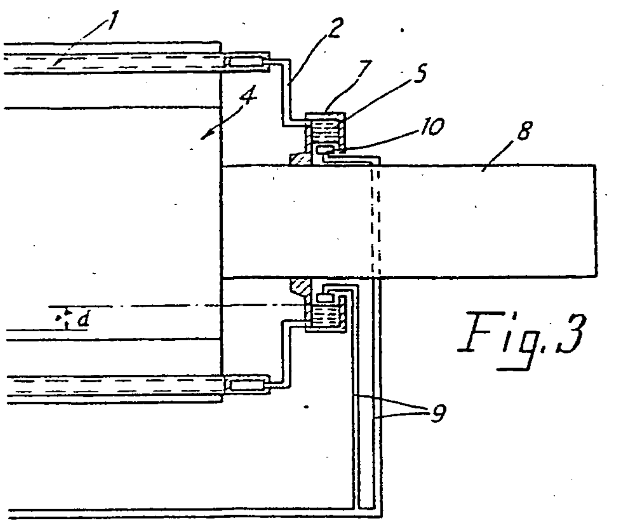

Fig. 3

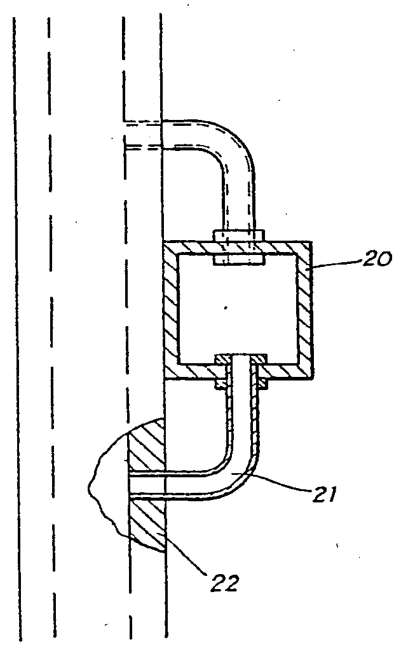

Fig. 7

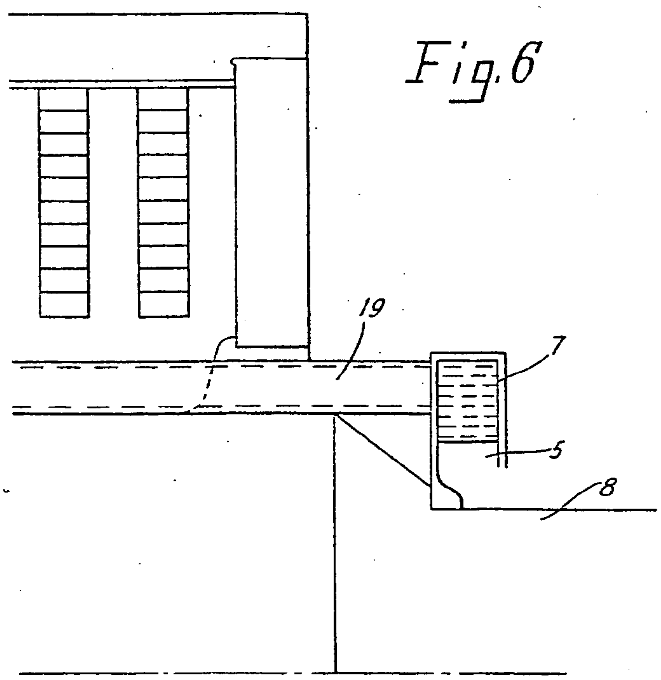

Fig. 6

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2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

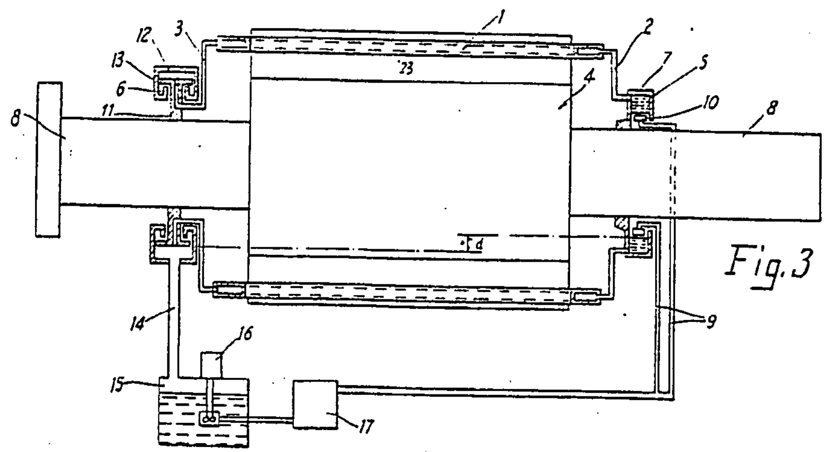

Fig.3

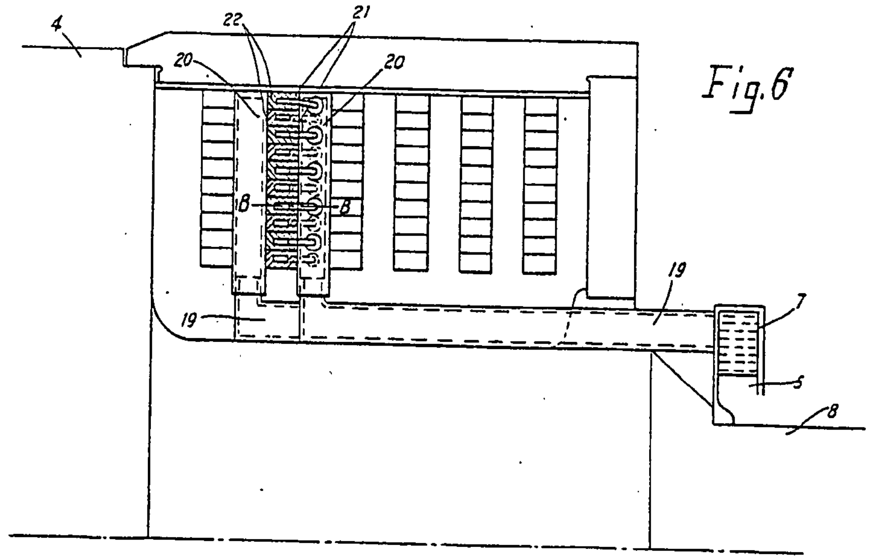

Fig.6

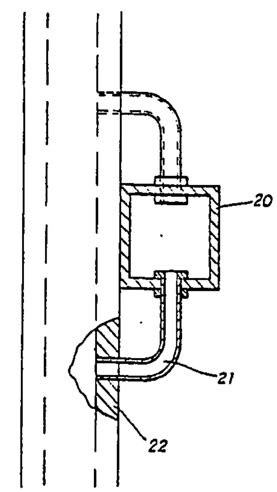

Fig.7